09/673814

422 Rec'd PCT/PTO 20 OCT 2000

Insβ1>
Insβ2>

Compressed-medium operated nippers

The invention relates to compressed-medium operated nippers for locking rings, clips, studs, cable lugs, and the like according to the preamble of claim 1. Generally, the compressed-medium operated nippers are suited for any objects that are squeezed in place.

Compressed-medium operated nippers specifically serve for permanently deforming locking rings so that they clip one part to another, e.g. a hose to a socket. For example, they are used in automobile manufacture. From DE 195 19 543 C2, compressed-medium operated nippers of the aforementioned type are known which have a compressed-medium connection point and a compressed-medium valve connected thereto, several driving pistons separated from each other which are controlled by the compressed-medium valve, a feed member adapted to be driven by the driving piston, and pivotally supported nipper insert halves the inner lever ends of which are engaged by the feed member to swivel them. These compressed-medium operated nippers are intended to ensure that the closing gap required for the nipper insert halves be reached while under a full build-up of forces and that a influence not dependent on the working pressure be favourably exerted on the closing forces. To this effect, the compressed-medium valve has a valve stem slidably guided in a direction transverse to the piston motion and which is adapted to be actuated by a release mechanism which, when in a rest position, blocks the connection of the driving pistons to the compresssed-medium connection point and joins these to a lower pressure level and which, when in a working position achievable by an actuation of the release mechanism, blocks the connection of the driving pistons to the lower pressure level and joins these to the compressed-medium connection point. What adds to this is that a connecting rod is kept movable in a guide extending in the direction of motion of the driving pistons and is biased by a spring towards the valve stem wherein the connecting rod has an outer offset as a driver and the driving piston has a transpierced shank receiving the connecting rod with an inner offset associated with the outer offset as a stop for carrying along the

.../2

connecting rod in the last section in its motion to close the nipper insert halves. For this purpose, the valve stem has a blocking seat in which the connecting rod is caught under the action of the spring while the valve stem is moving from the rest position to the work position and from which the connecting rod is released while being carried along by the driving piston. Consequently, the piston is always displaced by force from its initial position to a final position in which the nippers reach the required closing gap for an adequate duration of closure.

A particular ease in mounting and a modular adaptability of these compressed-medium operated nippers to varying force requirements are reached by the fact that the housing between the compressed-medium valve and the adjoiningly positioned driving piston has fixed in it a partition wall on which the spring which biases the valve stem is supported. It is reached by the further fact that the driving piston which is disposed next to the partition wall and is adjacent to the compressed-medium valve is T-shaped and supports the shank which is directed to the feed member and has the inner offset, on the succeeding driving piston. Hence, the devices for engaging and carrying along the connecting rod are limited to the partition wall and the adjoining driving piston. The other driving pistons may be manufactured, mounted, and serially staggered regardless of this, in the number necessary for the closing force required.

However, faulty mountings may occur also for these nippers, for example, if the fitter wrongly places the nippers on the locking ring or pressure variations are encountered in the compressed-medium network, which mostly is a compressed-air network.

A press-in effect monitoring system is known from the leaflet "Preßkraft-Meß- und Regeleinrichtung Typ SEP" of the Tox-Preßtechnik Company, Weingarten, received on July 21st, 1993, which system is employed on a press and can be delivered only along with a complete press. This state of the art discloses how to regulate and measure pressing forces in press-in and deforming operations,

for which purpose the real value is determined via an oil pressure sensor or force sensor and is fed, as a set value, to the proportional valve. What is depicted in details is how to use an oil pressure sensor. Details of how to use a force sensor cannot be deduced from this publication.

A multi-finger gripper which detects the gripping force and spatial reaction forces and moments is known from AT 395 124 B. It comprises a gripper housing, a trapezoidal spindle, and a restricted-guidance sliding block including a guide groove in which the toggle levers of parallelogram linkages to which grip fingers are fastened are guided. The pivots of the toggle levers of parallelogram linkages are axisymmetrically and uniformly spaced circumferentially on the inner ring of a deforming body of a force and torque feeler which is known per sé. This one comprises an inner ring, an outer ring fixed to the gripper housing, elastic elements interconnecting the two rings, and measured-data transmitters registering the deformation of the elastic elements. This registration of measured data which is based on the registration of reaction forces and moments on gear bearings of grip fingers is expensive, requires a lot of space, and is relatively inaccurate.

DE 21 18 782 C2 relates to a compressed-medium operated clipping tool to obtain pressure-sealed pipe connections, which is operated by a hand-actuated hydraulic pump. A pressure gauge responds to the pressure produced by the pump, is supervised by the operator, and signals the termination of the deforming process. This measuring device displays the force applied by clamping jaws to the pipes being locked with each other only in a relatively inaccurate manner.

Accordingly, it is the object of the invention to provide compressed-medium operated nippers which enable the mounting of locking rings and the like in a further improved quality with a view to reducing the expenditure in verifying the mounting of locking rings.

The object is attained by compressed-medium operated nippers having the features of claim 1. Advantageous aspects of the compressed-medium operated

nippers, which preferably are designed as a hand-held device, are indicated in the sub-claims.

Ins B3

The solution is characterized in that a force sensor is disposed in the flux of forces between the driving piston and the nipper insert halves for measuring a force dependent on the closing force of the nipper insert halves. Preferably, the force sensor on the feed member measures a force dependent on the closing force of the nipper insert halves. For this purpose, it may be mounted on the feed member or may be integrated therein. In addition, the compressed-medium operated nippers may be connected to an evaluation device which may be integrated in the compressed-medium operated nippers or may also be disposed outside the compressed-medium operated nippers. In particular, the evaluation device may serve for controlling a display and/or turning off the pair of nippers upon non-observance of a value preset for the closing force and/or for controlling the pressure of the compressed medium up to a value ensuring the attainment of a value preset for the closing force and/or for feeding the values measured to a documentation device for documenting the closing force. To this effect, the evaluation device may have appropriate devices or, in turn, may be connected to these.

The invention relies on the finding that the closing force of the nipper insert halves, i.e. the force applied by the nipper insert halves to a locking ring or the like, is dependent on the force encountered between the driving piston and the nipper insert halves. In particular, it was found that the force in the feed member, which preferably abuts, at a tapering front end which may be wedge-shaped or parabola-shaped, against the inner lever ends of the nipper insert halves and may be bolted to a piston at the other end, exhibits an almost ideal, linear dependence on the closing force. Hence, the closing force may be determined very precisely via the force sensor. What adds to this is that its arrangement in the flux of forces between the driving piston and the nipper insert halves does not interfere with mounting because it does not engage into the working range of the nipper insert halves. On the other

hand, it does not interfere either with the pressure buildup in the area of the driving pistons. In addition, it permits a unit-assembly system using compressed-medium operated nippers in which the measurement of forces may be carried out in an identical manner and which differ merely by their number of serially staggered pistons that is chosen depending on the closing force desired.

The force measured by the force sensor is utilizable in different ways within the scope of the invention. Thus, it may be utilized by an evaluation device for controlling a display such as an optical and/or acoustical display, and/or for turning off the compressed-medium operated nippers every time upon non-observance of the value preset for the closing force. The value preset for the closing force may be a minimum force which requires to be reached by all means. However, it also may be a maximum force or a minimum force and a maximum force which require to be observed at the same time. For example, if the nipper insert halves only act upon a marginal area of a locking zone of the locking ring the closing force reached will be only a fraction of the closing force that would be built up if the complete locking zone was acted on. However, in the event that the nipper insert halves are applied to a wrong zone of the locking ring, which is more difficult to deform than the nippers, an excessive closing force will result. The evaluation device is capable of detecting and signaling this and/or may turn off the compressed-medium operated nippers before time so that the operator may instantly recognize and correct the error.

In addition or instead, the evaluation device may control the pressure of the compressed medium causing the driving pistons to be driven so as to observe a value preset for the closing force. For this purpose, the evaluation device may resort to a pressure control valve which can be associated with the compressed-medium connection point and, at the same time, may be the compressed-medium valve which controls the motion of the driving pistons.

In addition or instead, the force measured may be documented by a documentation device such as a plotter and/or a PC having an electronic memory.

This creates the possibility of proving a quality in addition to the error analysis and the error check.

The force sensor is preferably integrated in the feed member. For example, it may be of a plate shape. Moreover, it may be disposed on the feed member side facing the piston. It is preferred that the force sensor is between two portions of the feed member. It may be guided at a central hole, e.g. if designed as a ring washer, on a stud which extends in the direction of the flux of forces and is anchored in the feed member, especially by bolting it in. A force measurement in both the series circuit and shunt circuit is envisaged wherein the whole flux of forces takes place via the sensor in the first case and the flux of forces runs via the sensor only in part in the second case. In either case, the sensor may be biased by a force.

An arrangement in a shunt circuit is provided particularly if the force sensor is held at a central hole on a stud between two portions of the feed member wherein the stud is bolted into the two portions at its two ends in order to apply a certain bias to the force sensor. The bias of the sensor defines the zero of force measurement.

The force sensor may be a foil strain gauge (FSG) sensor, a piezosensor or any other force sensor that is appropriate. Force sensors on an FSG or piezo basis exist in a plate shape, especially in a ring washer shape. It is mainly in this design that they are suited for being integrated in the feed member. In particular, FSG sensors may also be disposed on the shell of a feed member.

The compressed-medium operated nippers may have a pressure sensor to monitor the pressure of the compressed medium. This one sends the signal measured on to an evaluation device to output a display or turn off the compressed-medium nippers upon non-observance of a value preset for the pressure, a pressure regulation device and/or a documentation device to document the pressure.

The preset value mainly relates to a minimum pressure which is necessary to reach the closing force required. However, it may also relate to a maximum pressure which must not be exceeded in order to avoid inadmissibly high locking forces

.../7

which, for example, may lead to a destruction of the components requiring to be interconnected. Also, the preset value may comprise a minimum pressure and a maximum pressure. The evaluation device, by emitting an optical or acoustic display or turning off the compressed-medium nippers, informs the operator that the pressure required for mounting does not exist, which avoids faulty mountings. The latter, however, may also be avoided by the fact that the pressure sensor controls the pressure of the compressed medium via a regulation device. Thus, the pressure sensor may cause a pressure regulation unit to increase or decrease the feed pressure for the compressed-medium operated nippers. Finally, it is also possible to document the pressure by means of a documentation device in order to obtain a quality proof for the mounting of the locking ring in addition to error analysis and error avoidance.

It is preferred that the two solution variants are jointly realized in compressed-medium operated nippers. Further, compressed-medium operated nippers according to one of the solution variants or the combination thereof may be provided with the features of the compressed-medium operated nippers according to DE 195 19 543 C2 which ensures that the appropriate closing gap is achieved. This makes possible compressed-medium operated nippers which ensure that whenever a locking ring is mounted

- the compressed-medium pressure required is available
- the closing gap required is achieved, and
- the closing force assumes the correct values.

The invention will now be explained in greater detail with reference to the accompanying drawing of an embodiment of the compressed-medium operated nippers for the manual mode of operation. In the drawing,

Fig. 1 shows the compressed-medium operated nippers, partially in a longitudinal section, with details of the control portion omitted;

Fig. 2 shows the compressed-medium operated nippers in a section along lines II-II of Fig. 3;

Fig. 3 shows the compressed-medium operated nippers in a side view with the nipper insert halves and the lateral elements supporting them omitted;

Fig. 4 shows the compressed-medium operated nippers in a rear view;

Fig. 5 shows the compressed-medium operated nippers in a plan view with the nipper insert halves and the lateral elements supporting them omitted;

Fig. 6 shows the compressed-medium operated nippers in a section along lines VI-VI of Fig. 5.

Ins B5 The compressed-medium operated nippers substantially have four functional ranges: working range 1, driving range 2, measuring range 3, and control range 4.

The working range 1 has a substantially annular nipper head 5 which is gripped over by a locating ring 7 on a flange 6 and is bolted in place at one end of a cylindrical housing 8. On either side, lateral parts 11 are fixed by means of studs 10 to forwardly protruding portions 9 of the nipper head 5.

The lateral parts 11 are traversed by two insertion studs 12 which are directed transversely thereto with a nipper insert half 13 being pivotally supported on either insertion stud 12. The two nipper insert tips 14 at the front end of the nipper insert halves 13 can be swiveled together, leaving a closing gap. At this point, the nipper insert tips 14 apply a closing force to a locking ring disposed therebetween with a locking zone. The nipper insert halves 13 carry rollers 15 at their inner lever ends. When in a rest position, the nipper insert tips 14 are swiveled apart by at least one spring (not shown) which engages the nipper insert halves 13 until the rollers contact each other. Nipper halves which are of a different geometry at the front may be mounted as well in order to squeeze in place objects other than locking rings.

The driving range 2 has a feed member 17 of a circular cross-section which protrudes from the housing 8 and extends into an axial bore 16 of the nipper head 5.

The member has a forward portion 17' and a rearward portion 17". At its front, the forward portion 17' has a wedge-shaped portion 17"' which exhibits a large wedge angle directly at the front and a smaller wedge angle behind it. The two portions 17', 17" are connected to each other by an axially directed stud 18.

Centrally seated on the stud 18 between the two portions 17', 17" of the feed member 17 is an annular ring washer shaped force sensor 19. It may be an FSG sensor or a piezosensor. Seated on either side of the force sensor 19 are circular ring washers 20 on the stud 18. The stud 18 is tightened at a defined torque so that the portions 17', 17" of the feed member 17, via the circular ring washers 20, apply a defined biasing force to the force sensor 19 which typically is 10 % of the maximum force measurable by the force sensor 19. The outside diameters of the circular ring washers 20 and that of the force sensor 19 correspond to the outside diameters of the portion 17".

At the circumference of the force sensor 19, a connecting cable 21 is led out radially and in a sealing relationship to the sensor housing and is led to the outside through a slot 22 of the nipper head 5. The slot 22 extends across the whole range of displacement of the force sensor 19, which is defined by its initial position with the nipper insert halves 13 completely opened and its final position with the closing gap reached, by pressing in the wedge-shaped portion 17"' between the rollers 15.

The slot 22 is externally covered by a hood 23 which is flanged to the side of the nipper head 5 at 24 and laterally projects somewhat beyond the locating ring 7 and the housing 8. The hood 23 has a vaulted cavity 25 which allows the connecting cable 21 to be deformed while the force sensor 19 is being displaced. The shell of the housing 8 has seated on it a strip 26 which is of the cross-section of half a circular tube and is locked in place, at one end, below the overhung range of the hood 23 and is locked, at the other end, below a plate 27 which is externally bolted to the control range 4. Below the strip 26, the connecting cable 21 is passed to the control range 4 and is located on the housing 8. Moreover, the plate 27 has locked in

place below it a hose 28 which is led away rearwards and in which the connecting cable 21 is led to an evaluation device and/or a documentation device. Instead, it will also be possible to accommodate an evaluation device and/or documentation device directly in or on the compressed-medium operated nippers.

The driving range 2 further comprises an array of serially staggered pistons. These include a disk-shaped driving piston 29 which is fixed by means of a bolt 30 to the rear front-end face of the portion 17" of the feed member 17. The driving piston 29 is circumferentially sealed towards the housing 8 and is guided therein in an axial movable relationship.

Seated at the outside of the portion 17", next to the piston 29, is a sleeve 31 which, acting as a stop, limits the motion of the driving piston 29 to the nipper head 15. Thus, the sleeve 15 protects a helical return spring 32 which is supported on the driving piston 29, at one end, and on the nipper head 5, at the other end and tries to force the driving piston 29 away from the nipper head 5. The return spring 32 urges the driving piston 29, when relieved from pressure, up to a ring washer shaped partition wall 32 which is fixed in the housing 8. Also fixed in the housing 8 are another partition wall 33 at a distance from the partition wall 32 and yet another partition wall 34 at an adequate distance from the partition wall 33.

The central apertures of the ring washer shaped partition walls 32, 33, 34 have sealingly guided therein shanks 35, 36, 37 each of T-shaped driving pistons 38, 39, 40. These have piston disks 41, 42, 43 which are circumferentially guided in the housing 8 in a sealing relationship and are axially movable therein. Because the driving pistons 38, 39, 40 are supported on the driving piston 29 and also support each other they will be shifted back, when relieved from pressure, by the return spring 32 until they bear against the partition walls 33, 34 and a shoulder 44 of the control range 4.

The driving pistons 38, 39, 40 are provided with central, axially directed through bores 45, 46, 47 which communicate with recesses 48, 49, 50 at the ends of

the shafts 35, 36, 37 which are seated on adjoining driving pistons. Now, if compressed air is fed from the control range 4 to that side of the piston disk 43 which faces it this air will pressurize the piston disks 29, 41, 42 all at once via the through bores 45, 46, 47 and the recesses 48, 49, 50. As a result, all of the driving pistons 29, 38, 39, 40 will be displaced towards the working range 1 where the feed member 17, using its wedge-shaped portion 17''', presses the rollers 15 apart and swivels the nipper jaws 14 together. In contrast, if the driving pistons 29, 38, 39, 40 are pressurized by an atmospheric pressure rather than by compressed air from the control range 4 the return spring 32 will shift the driving pistons 29, 38, 39, 40 back to their initial position. At this point, the no-pressure side of the driving piston 29 is aerated by the nipper head 5 and the no-pressure side of the driving pistons 38, 39, 40 is aerated by the aeration apertures 51, 52, 53 in the housing 8.

A control housing 54 of the control range 4 has pivotally supported on it a release lever 55 which is forced away from the housing 8 by a spring (not shown). The control housing 54 is bolted onto the rear end of the housing 8. Swiveling the release lever 55 to the housing 8 will apply compressed air to the driving pistons 29, 38, 39, 40 by and relieving the release lever 54 from pressure will connect them to the atmosphere. When operated, the release lever 55 will act on a compressed-medium valve (not shown for reasons of simplicity), which is joined to a compressed-medium line via a compressed-medium connection point 56 and to the atmosphere of the control housing 54 via an aperture.

The control range 4 may be designed as is described in the Utility Model DE 89 00 250. However, it preferably is designed as is depicted in DE 195 19 543 C2. Then, it will have a valve stem which, in particular, is slidable in a direction transverse to the piston motion and is adapted to be actuated by the release lever 55 and interacts with a connecting rod guided on a further partition wall which, in turn, interacts with the piston 40 in order to ensure that a given closing gap be reached.

.../12

When the nipper insert tips 14 of the nipper insert halves 13 are swiveled together a force is transmitted, via the feed member 17, which is also transmitted via the force sensor 19 in a shunt. This force is linearly dependent upon the closing force effective between the nipper insert tips 14. It is subjected to evaluation and documentation via the connecting cable 21, which provides for a check of the quality in clip mounting.

Additionally, the compressed air fed to the compressed-medium connection point 56 is monitored via a pressure sensor 57 disposed in the control range 4 or disposed externally in order that if the pressure falls below the preset minimum or exceeds a preset maximum the mounting of a locking ring is prevented or corrected, in which case the air pressure is automatically re-adjusted, if necessary. The pressure sensor 57 is connected, via a further connecting cable 58, with an evaluation device and/or change-over device and/or regulating device and/or documentation device which is external here.

The embodiment makes it evident that if a desired closing force is to be achieved it is merely the number of serially staggered pistons 29, 38, 39, 40 and, accordingly, the length of the housing 8 which needs to be changed. It is always the same feed member 17 with its integrated force sensor 19 which can be employed here, and the working range 1 and the control range 4 need not be changed.